

## Title of the Invention

## SHEET POST-PROCESSING APPARATUS

## 5 Cross-Reference to Related Application

This is a continuation application of Serial No. 09/984,330 filed on October 29, 2001.

## Background of the Invention and Related Art Statement

10 The present invention relates to a sheet post-processing apparatus and an image forming apparatus having the same therein, particularly for binding a stack of sheets.

In some prior image forming apparatuses including copiers, printers, facsimile machines, and machines combining the same,  
15 there is a type such that sheets discharged from an image forming apparatus is piled, and a piled sheet bundle is stapled or stitched together by a post-processing apparatus disposed therein.

Such sheet post-processing apparatuses have a stitching unit having a head unit for driving staples, and an anvil unit for  
20 receiving and bending the staples driven out of the head unit.

This allows not only end stitching in which stapling is made on edges of the sheet bundle, but also so-called saddle stitching in which stapling is made at about center portion of the sheet bundle.

25 The prior sheet post-processing apparatus, as disclosed in Japanese Patent Publication (KOKAI) No. 07-157180, has a partial guide disposed directly on the head unit and the anvil unit for guiding the sheet bundle passing through between the head unit and the anvil unit.

30 However, the prior sheet post-processing apparatuses have the guide extending partially in the width direction of the sheet bundle. The width direction of the sheet bundle is a direction traversing the sheet bundle feed direction and virtually parallel to the sheet bundle facing the head unit and the anvil unit.

35 For this reason, some prior sheet post-processing apparatuses have such disadvantages that the partial guide can not guide and support the sheet bundle for the whole width. As a result, edges of the sheet bundle in the width direction are

hung down when the sheet bundle is fed or stapled thereon, or the sheet bundle is too deformed in posture to stitch correctly, or the edges of the sheet bundle are folded after stitching.

5 Other sheet post-processing apparatuses, on the other hand, have the guide extending over virtually entire width of the sheet bundle. The guide can guide and support the entire width. However, the sheet post-processing apparatuses also have the disadvantage such that the sheet bundle is caught on the extending edge by the space between the head unit and the anvil unit. As a result,  
10 the sheet bundle is too deformed in posture to stitch correctly, or the edge of the sheet bundle is folded after stitching.

In view of the foregoing problem of the prior art, it is an object of the present invention to provide a sheet post-processing apparatus, wherein a sheet bundle can be fed  
15 securely and stitched correctly, and an image forming apparatus having the same therein.

Further objects and advantages of the invention will be apparent from the following description of the invention.

## 20 Summary of the Invention

In one aspect of the present invention, a sheet post-processing apparatus comprises a head portion for driving a staple into a sheet bundle; an anvil portion opposingly arranged to the head portion for receiving and bending the staple driven  
25 from the head portion; feeding means for feeding or passing the sheet bundle between the head portion and the anvil portion; a guide member positioned between the head portion and the anvil portion for guiding the sheet bundle; and an auxiliary guide member disposed on an upstream side of the guide member in a sheet  
30 bundle feed direction of the sheet bundle fed by the feeding means.

The auxiliary guide member leads the sheet bundle to the guide member without touching a leading edge of the sheet bundle fed by the feeding means on an upstream edge of the guide member in the sheet bundle feed direction.

35 In accordance with another aspect of the invention, a sheet post-processing apparatus comprises a head portion for driving a staple into a sheet bundle; an anvil portion opposingly arranged to the head portion for receiving and bending the staple driven

from the head portion; feeding means for feeding or passing the sheet bundle between the head portion and the anvil portion; a guide member positioned between the head portion and the anvil portion for guiding the sheet bundle; moving means for moving  
5 the head portion and the anvil portion in a direction traversing a sheet bundle feed direction of the sheet bundle fed by the feeding means; and an auxiliary guide member disposed on an upstream side of the guide member in the sheet bundle feed direction of the sheet bundle fed by the feeding means. The  
10 auxiliary guide member leads the sheet bundle to the guide member without touching a leading edge of the sheet bundle fed by the feeding means on an upstream edge of the guide member in the sheet bundle feed direction.

In accordance with a further aspect of the present invention,  
15 an image forming apparatus comprises an image forming portion; a head portion for driving a staple on a sheet bundle discharged from the image forming portion and stacked; an anvil portion opposingly arranged to the head portion for receiving and bending the staple driven from the head portion; feeding means for feeding  
20 or passing the sheet bundle between the head portion and the anvil portion; a guide member positioned between the head portion and the anvil portion for guiding the sheet bundle; an auxiliary guide member disposed on an upstream side of the guide member in the direction of a sheet bundle fed by the feeding means; and a  
25 stacking portion for stacking the sheet bundle stitched by the head portion and the anvil portion. The auxiliary guide member leads the sheet bundle to the guide member without touching a leading edge of the sheet bundle fed by the feeding means on an upstream edge of the guide member in the sheet bundle feed  
30 direction.

#### Brief Description of the Drawings

Fig. 1 is a front cross-sectional view for a copier having a folded sheet stacking device built in a main body thereof;

35 Fig. 2 is a front cross-sectional view for a sheet post-processing apparatus having the folded sheet stacking device built therein;

Fig. 3 is a plan view for a processing tray of the sheet

post-processing apparatus;

Fig. 4 is a front view for a stopper arrangement.

Fig. 5 is a front view for a plurality of stopper arrangements;

5 Fig. 6 is a perspective view for a stapler unit;

Fig. 7 is another view for a base section and an attachment section of the stapler;

Fig. 8 is a block diagram for the sheet post-processing apparatus;

10 Fig. 9 is another view for a base section and an attachment section of the stapler;

Fig. 10 is a view for space detecting means;

Fig. 11 is a view for space detecting means;

15 Fig. 12 is an enlarged view for a transfer belt portion of the sheet post-processing apparatus;

Fig. 13 is a view for a stapler unit of the sheet post-processing apparatus as viewed in a sheet feed direction;

Fig. 14 is another view for the stapler unit of the sheet post-processing apparatus as viewed in the sheet feed direction;

20 Fig. 15 is still another view of the stapler unit of the sheet post-processing apparatus as viewed in the sheet feed direction;

Fig. 16 is an operational view for a stopper of the sheet post-processing apparatus;

25 Fig. 17 is a cross-sectional view for the stopper in relation to the sheet stack when the stopper is returned to a restricting position;

Fig. 18 is a perspective view for showing a relationship between a feed guide and a pre-guide;

30 Fig. 19 is a plan view for showing a relationship between the feed guide and the pre-guide; and

Fig. 20 is a view for a sheet bundle folding operation of a folding unit disposed in the sheet post-processing apparatus.

## 35 Detailed Description of Preferred Embodiments

The following describes in detail embodiments of the sheet post-processing apparatus according to the present invention in reference to the drawings provided.

Fig. 1 illustrates a main body of a copier that is an example of an image forming apparatus provided with a sheet post-processing apparatus according to the present invention.

In the figure, the main body 1 of the copier 20 comprises a platen glass 906 used as an original table, a light source 907, a lens system 908, a sheet feeder 909, and an image forming section 902.

The main body 1 is equipped with an automatic document feeder 940 thereon for automatically feeding an original D to the platen glass 906.

The sheet feeder 909 has cassettes 910 and 911 mountable to the main body 1 for storing recording sheets S and a deck 913 disposed on a pedestal 912. The image forming section (image forming means) 902 is equipped with a cylindrical photo-conductor drum 914, and arranged thereabout are a developer 915, a transfer charger 916, a separation charger 917, a cleaner 918, and a primary charger 910. Downstream of the image forming section 902, there are arranged a feeding apparatus 920, a fixing device 904, and paired discharge rollers 1a and 1b.

The following describes operations of the mechanisms inside the main body 1 of the copier 20. When a paper feed signal is output from the control unit 921 disposed in the main body 1, the sheet S is fed out of the cassette 910 or 911, or the deck 913. The light source 907 generates light to the document D on the platen glass 906. The light is reflected by a document D and irradiated through the lens system 908 to the photo-conductor drum 914. The photo-conductor drum 914 is charged in advance by the primary charger 910 and has an electrostatic latent image formed thereon by the light irradiated thereto. In turn, the photo-conductor drum 914 has the electrostatic latent image developed to form a toner image by the developer 915.

The sheet S fed from the sheet feeder 909 is skew-corrected and timing-adjusted by a register roller 901 before being fed to the image forming section 902. On the image forming section 902, the transfer charger 916 transfers the toner image on the photo-conductor drum 914 to the sheet S fed therein. The sheet S having the toner image transferred thereto is charged to a polarity reverse to the transfer electrode 916 by the separating charger 917 before being separated from the photo-conductor drum

914.

The separated sheet S is fed to the fixing unit 904 by the feeding apparatus 920. The fixing unit 904 permanently fixes the transferred image onto the sheet S. The sheet S having the image fixed thereon is discharged out by the paired discharge rollers 1a and 1b. The sheet S fed from the sheet feeder 909 in this way has the image formed thereon and is discharged to the sheet post-processing apparatus 2.

Fig. 2 illustrates the sheet post-processing apparatus, also referred to as a "finisher", 2 that is disposed on the side of the main body 1 of a copier.

The discharge roller 1a and the discharge roller 1b pressed to the discharge roller 1a are equipped on the main body 1 of the copier 20 form the paired discharge rollers. Paired feed guides 3 receive the sheet discharged from the paired discharge rollers 1a and 1b, and guide the sheet into the sheet post-processing apparatus 2. A sheet detecting sensor 4 detects the sheet fed in the feed guide 3. Detecting the sheet by the sheet detecting sensor 4 serves to determine the timing for aligning and to signal whether or not the sheet has jammed inside of the feed guide 3. Paired discharge rollers 6 rotate to support the sheet in the feed guide 3 sandwiched therebetween to feed it.

The processing tray 8 receives the sheets discharged continuously by the paired discharge rollers 6 for stacking. Paired aligning plates 9 are disposed on the processing tray 8 to guide and align both of the edges of the sheet, i.e. width, discharged by the paired discharge rollers 6. Each of the aligning plates 9, as shown in Fig. 3, is arranged on a side of the respective edges in the width direction traversing the direction of the sheet fed. Each of the aligning plates 9 is meshed with a pinion 15 arranged on a shaft of one of aligning motors 14 formed of a stepping motor arranged below the processing tray 8. Racks 16 are integrated with the respective aligning plates 9 and disposed on the processing tray 8 to be moved appropriately in the width direction of the sheet by rotations of the front side aligning motor 14 and the rear side aligning motor 14. The racks 16 align the sheets based on the center in the width direction

of each sheet discharged according to either type of the copier that discharges the sheets by aligning at the center in the width direction of each sheet, or the type that aligns either the right or left edge of each sheet, or a type that can align based on  
5 either the right or left edge in the width direction of each sheet.

The feed guide 7 shown in Fig. 2 is a guide for guiding into the processing tray 8 the sheets discharged out of the paired discharge rollers 6. A paddle 17 is situated below the feed guide 7. The paddle 17 is formed of a semicircular rubber having a  
10 fixed elasticity and designed to rotate with a center of a shaft 17a in contact with an upper surface of the sheet to securely feed the sheet. The paddle 17 also has a fin 17b extending radially with the center of the shaft 17a and a paddle surface 17c integrated into one unit. The paddle 17 is designed to easily  
15 deform as the sheets are stacked in the processing tray 8 so that the sheets can be fed properly.

The processing tray 8, as shown in Fig. 2, also has a first pulley 10 situated on a first pulley shaft 10a on one side thereof and has a second pulley 11 formed on a second pulley shaft 11a  
20 on the other side thereof. A feed belt 12 is disposed between the first pulley 10 and the second pulley 11. The feed belt 12 has a pressing pawl 13 on a part of the circumference of the feed belt 12.

The first pulley shaft 10a has a lower feed roller 18 mounted  
25 axially thereon. An upper feed roller 19 is located above the lower feed roller 18 to move between a position (dotted line in Fig. 2) where the upper feed roller 19 presses the lower feed roller 18, and a separating position (solid line in Fig. 2) where the upper feed roller 19 is separated from the lower feed roller  
30 18.

The stopper 21 has a single stopper plate 421 extending in the width direction of the sheet as shown in Fig. 4. The stopper plate 421 receives and limits the edge of the sheet moved by the rotation of the paddle 17, and discharged and dropped under its  
35 own weight into the processing tray 8 by the paired discharge rollers 6. The stopper 21 is rested at an end thereof by a first pulley shaft 10a and always protrudes toward a position that limits the edge of the sheet by a spring or the like (not shown).

The stopper 21, made of a single plate, may be replaced by a plurality of stoppers 221 arranged in the width direction of the sheet as shown in Fig. 5.

The saddle stitching unit 30, as shown by linked double-dashed line in Fig. 2, forms a unit that allows the saddle stitching unit 30 to be drawn out of the sheet post-processing apparatus 2. The saddle stitching unit 30 has a staple driving head unit 31 having a staple cartridge (not shown) and an anvil unit 32 for bending the staple driven out of the staple driving head unit 31, the units 31 and 32 being formed below and above a sheet bundle feed path 25, respectively. The staple driving head unit 31 and the anvil unit 32 can be moved in the sheet bundle feed path 25 formed therebetween in a direction traversing the sheet bundle feed direction (from left to right in Fig. 2), the traversing direction being a direction along the front and back surfaces of the sheet bundle facing the staple driving head unit 31 and the anvil unit 32. Guide rods 33 and 34 are situated above and below to guide the staple driving head unit 31 and the anvil unit 32 in the direction traversing the sheet bundle feed direction. Screw shafts 35 and 36 are shafts to shift the anvil unit 32 and the staple driving head unit 31. An anvil drive shaft 37 and a head drive shaft 38 are shafts that make the anvil unit 32 and the staple driving head unit 31 drive to bend the staples respectively.

The head housing 224 is included in the staple driving head unit 31 together with the guide base block 208, as shown in Fig. 6. The head housing 224 is formed to be integrated into one body with the guide base block 208. The guide rod 34 passes through the guide hole opened in the guide base block 208 while abutting thereby guiding the swinging movement of the driving head unit 31.

An attachment block 207 is formed in the vicinity of the head housing 224, as shown in Fig. 6. The attachment block 207 includes a transmission gear 230 and an arm 229 for transmitting the drive force of the drive shaft 38 to a staple blade (not shown) inside the head housing 224. The pin 232 is disposed on the transmission gear 230 and moved along a cam face 231 of the arm 229. The recess in the leading edge of the arm 229 makes the



pin 297 installed fixedly at the staple blade inside the head housing 224 move along a slit 227 inside the head housing 224, thereby providing the drive force to the staple blade.

Fig. 7 illustrates that the attachment block 207 is mountably attached to the guide base block 208 and the head housing 224 disposed to be integrated into one body in the directions of arrows A and B. The attachment block 207 is positioned by the positioning pin 299 on the head housing 224 engaged with a recess thereof and is fixed by a screw (not shown).

Furthermore, the guide base block 208 and the attachment block 207 are provided with positioning sensors 280a and 280b.

The positioning sensors 280a and 280b detect whether or not the attachment block 207 is attached to the guide base block 208 and the head housing 224, and detect whether or not the attachment block 207 is attached to the correct position.

Such an arrangement allows only the attachment block 207 to be removed when a staple is jammed or in similar problems, thereby increasing maintenance efficiency. The arrangement also allows the head housing 224 including the staple driving staple blade (not shown) to remain in the apparatus together with the guide base block 208, so there is no deviation of the relative position to the staple blade and the anvil body 241, which requires high precision, even when mounting or dismounting for maintenance, thereby preventing later stitching errors.

Fig. 8 shows a control block 149 which inhibits the driving head unit 31 and the anvil unit 32 from saddle stitching according to detection results of the positioning sensors 280a and 280b if the attachment block 207 is not attached or has been attached in a position that is incomplete. Such an operation can prevent staple stitching errors if a staple is clogged or actually not driven.

In the embodiment described so far, as for the saddle stitching inhibit control according to the detection results of the positioning sensor when the attachment block is mounted and removed, it may be made possible by such a construction that a head 224a having the staple blade is integrated with attachment block 207a as shown in Fig. 9. For that construction, the detection results are obtained by a positioning sensor 281a formed

on a guide base block 208a and a positioning sensor 281b formed on the attachment block 207a.

It is also possible to use an alternative structure for the anvil unit 323 to comprise the guide base block 308 and an attachment block 307 mountably attached thereto thereby prohibiting the stitching process based on the detection results obtained by the positioning sensor 282a located on the guide base block 308 and the positioning sensor 282b located on the attachment block 307. This construction is the same as that shown in Fig. 6.

Furthermore, according to this embodiment, it is controlled to prohibit the saddle stitching based on the positioning detection detected by the control block 149 on the sheet post-processing apparatus when the attachment block is mounted and dismounted. However, it may also be made in an alternative way by using an additional control means formed in the saddle stitching unit 30 itself. Still a further alternative method would be made to have the control unit 921 in the main body 1.

The saddle stitching unit of the present embodiment, as shown in Figs. 10 and 11, has a gap detecting sensor 350 for detecting a gap between the staple driving head unit 31 and the anvil unit 32. In such a structure, the drive force of the drive shaft 38 is transmitted via a timing belt 45 and a staple/folding motor 170 located on the anvil drive shaft 37 in the anvil unit 32 to gears 171 and 175.

The cam 173 formed on the rotating shaft 180 on the gear 175 is engaged with a fixed frame 111 on the anvil unit 32. A movable frame 140 on the anvil unit 32 supported via a collar 142 on the anvil drive shaft 37 to swing freely, as shown in Fig. 11, resists against the urging force of the coiled spring 157 to separate from the fixed frame 111 toward the driving head unit 31. Thus, the drive force of the head drive shaft 38 is transmitted to the gear 230 via the gear 34 formed on the head drive shaft 38 in synchronization with the drive force of the head drive shaft 38 that moves the movable frame 140 of the anvil unit 32 via the timing belt 45.

The circular cam 232 formed inside the gear 230 has a notch 235 thereon. A detection lever 366 comprising an engaging portion

360 and a detecting end 362 is rotatably situated around the shaft 363 and is constantly urged toward the cam 232 by the spring 364.

If the gap between the driving head unit 31 and the movable frame 140 of the anvil unit 32 is fully opened, as shown in Fig. 10, an engaging portion 360 on the detecting lever 366 can enter the cut-out 235 on the circular cam 232 by the spring 364. This moves the detecting tip 365 on the detecting end 362 around the shaft 363 and is detected inside the gap detecting sensor 350. The gap detecting sensor 350 detects the detecting tip 365 to notice that the space between the driving head unit 31 and the movable frame 140 of the anvil unit 32 is fully opened, as shown in Fig. 10.

On the other hand, if the drive force of the head drive shaft 38 moves the movable frame 140 on the anvil unit 32 via the timing belt 45, as shown in Fig. 11, the gear 230 is rotated via the gear 34' disposed on the head drive shaft 38 to engage the circular cam 232 with the detecting lever 366. This resists the urging force of the spring 364 to press the engaging portion 360 on the detecting lever 366 from the cut-out 235 up to the engaging surface of the circular cam 232.

The engaging portion 360 has a slant surface formed at the tip 361 thereof so that the engaging portion 360 can be pressed to the engaging surface on the circular cam 232. Thus, the detecting tip 365 on the detecting end 362 is not detected by the gap detecting sensor 350 when moved outside the gap detecting sensor 350 with respect to the shaft 363 while the engaging portion 360 on the detecting lever 366 is pressed and engaged with the engaging surface on the circular cam 232.

That is, as the gap detecting sensor 350 does not detect the detecting tip 365, it is found that the space between the driving head unit 31 and the movable frame 140 on the anvil unit 32 is not in a full open state, as shown in Fig. 11, unlike Fig. 10. The gap detecting sensor 350 detects whether or not the space between the driving head unit 31 and the movable frame 140 on the anvil unit 32 is fully open, as in Fig. 10. In addition, it is possible that the slit length of the gap detecting sensor 350 can be made longer to detect a range from the full open status to the desired narrower space.

The driving head unit 31 and the anvil unit 32 must be moved in the width direction of the sheet bundle if the saddle stitching is performed at a plurality of positions in the width direction of the sheet bundle, or if the driving head unit 31 and the anvil unit 32 are moved to a staple replacement position to replace the staples. For the saddle stitching unit 30 in the present embodiment, however, the control block 149 inhibits the driving head unit 31 and anvil unit 32 from moving toward the width direction of the sheet bundle in the condition that the gap detecting sensor 350 detects that the staple driving head unit 31 and the anvil unit 32 have a gap therebetween less than the predetermined range (other than the full open status as in Fig. 10). Such undesirable trouble happens often, for example, particularly if the sheet bundle is floating by the curling of the sheets, or if the sheet bundle is bulky due to too many sheets or is too thick as a sheet bundle. The trouble is caused by the sheet bundle positioned for saddle stitching at a loading portion between the driving head unit 31 and the anvil unit 32 coming into contact with the driving head unit 31 or the anvil unit 32. This deforms the posture of the sheet bundle aligned once by the aligning plates 9 resulting in the sheet bundle being stapled in the unaligned state.

Therefore, in this embodiment, the posture of the sheet stack is not deformed by any contact if the space is detected to exceed the predetermined distance. That is, in the status shown in Fig. 10, the control block 149 permits the driving head unit 31 and the anvil unit 32 to move in the width direction of the sheet stack. Therefore, the posture of the sheet stack is not deformed by any contact if it detects that the space exceeds a predetermined distance, that is, in the status shown in Fig. 10. The control block 149 then permits the driving head unit 31 and the anvil unit 32 to move in the width direction of the sheet stack.

However, as will be explained later, there could be a case that a sheet presence detection sensor (not shown) detects that the sheet stack is not present in the gap between the driving head unit 31 and the anvil unit 32. The case occurs, as an example, if the sheet stack does not reach the gap between the driving head unit 31 and the anvil unit 32 in the state that the pre-guide

370 for guiding the sheet stack to a feed guide 39 is moved to a predetermined position and idles. In that case, movements of the driving head unit 31 and the anvil unit 32 in the width direction of the sheet stack do not deform the posture of the sheet stack. The control block 149, therefore, permits the driving head unit 31 and the anvil unit 32 to move in the width direction of the sheet stack even if the gap detecting sensor 350 detects that the driving head unit 31 and the anvil unit 32 have a gap narrower than a predetermined value. This allows the driving head unit 31 and the anvil unit 32 to return to the home staple position that will be explained later.

This embodiment makes the above-described movement inhibit control in the width direction of the sheet bundle by way of detecting the gap between the driving head unit 31 and the anvil unit 32 on the saddle stitching unit 30. However, this method of control can be applied to all types of the mechanisms that move a stapler along the edge of a sheet bundle and bind the sheet bundle with a plurality of bindings other than a saddle stitch mechanism that mechanically links the head and the anvil. If a gap between the head and the anvil is detected to be too narrow, the stapler may be inhibited from moving along the edge of the sheet bundle.

The embodiment described above is for inhibiting the stapler movement when the gap is narrow, based upon the gap detection between the head and the anvil in the type of apparatus in which the stapler moves. However, in the type of a mechanism with a stapler in which the sheet bundle moves to the gap between the head and anvil, other than the saddle stitching unit or the saddle stitching that mechanically links the head and anvil, the sheet bundle may be inhibited from moving if the gap is detected to be too narrow according to the gap detection of the head and the anvil.

In other words, the relative movement of the sheet bundle to the stapler may be inhibited if the gap is detected to be too narrow according to the gap detection between the head and the anvil.

In place of the control block 149 on the sheet post-processing apparatus 2, alternatively, control means may

be formed in the saddle stitching unit 30 itself so that the control means can inhibit the driving head unit 31 and the anvil unit 32 from moving in the width direction of the sheet bundle according to the gap detection between the driving head unit 31 and the anvil unit 32. Still another alternative is that the control unit 921 of the main body 1 may be used to make the control for the image forming system.

The embodiment explained above has the anvil unit 32 moved toward the driving head unit 31 thereby changing the gap. Alternatively, the driving head unit 31 may be moved toward the anvil unit 32. Still, a further alternative could be that both units may be moved toward each other.

It is also possible to form a plurality of gap detection sensors in a structure to automatically set to a predetermined gap using control means that automatically selects the gap detection sensor according to conditions, such as the number of sheets, the thickness of the paper of the sheet itself or the humidity or other conditions.

The fixed feed guide 39 is designed to guide the sheet bundle fed inside the saddle stitching unit 30.

The folding unit 50 for the sheet bundle is the unit indicated by chain double-dashed line in Fig. 2, and can be drawn out of the sheet post-processing apparatus 2 as in the saddle stitching unit 30. A stack feed guide 53 guides the sheet bundle nipped and fed between the upper feed roller 19 and the lower feed roller 18 located at the inlet of the saddle stitching unit 30. The upper stack feed roller 51 is located at the inlet of the folding unit 50. The lower feed roller 52 is located to face the upper bundle feed roller 51.

The upper bundle feed roller 51 moves between a position indicated by solid lines in Fig. 2 that presses the lower bundle feed roller 52 and a retract position indicated by dashed lines in Fig. 2. The upper bundle feed roller 51 is separated at the position indicated by the dashed lines in Fig. 2 from the lower feed roller 52 until the leading edge of the sheet bundle passes over the upper bundle feed roller 51 and the lower feed roller 52 by the upper feed roller 19 and the lower feed roller 18 placed at the inlet on the saddle stitching unit 30, and moves to a

position indicated by the line in Fig. 2 to touch the lower feed roller 52.

A stack detecting sensor 54 for detecting the leading edge of the sheet bundle presses the upper stack feed roller 51 against the lower feed roller 52 when detecting the leading edge of the sheet bundle. The stack detecting sensor 54 is also used to set and control the folding position in the feed direction of the sheet bundle. An abutting plate 55 comprises a stainless steel plate, the leading end thereof being approximately 0.25 mm thick.

The paired folding rollers or sheet folding rotors 57a and 57b are cylindrical rollers having flat parts extending in a direction traversing the direction of the sheet bundle fed. Both the rollers are urged in the directions to press each other when rotated.

The abutting plate 55 is positioned right above the paired folding rollers 57a and 57b, and a leading edge thereof can be moved close to the nips of the paired folding rollers 57a and 57b. Around the upper portion of the paired folding rollers 57a and 57b, there are formed ark-like backup guides 59a and 59b to guide and feed the sheet bundle together with the stack feed guide 53.

The backup guides 59a and 59b are interconnected to move with the abutting plate 55 moving up and down to make an opening around the sheet bundle for the paired folding rollers 57a and 57b when the leading edge of the abutting plate 55 moves close to the nips of the paired folding rollers 57a and 57b. The guide 56 for the sheet bundle guides downward the sheet bundle being nipped and fed by the upper stack feed roller 51 and the lower feed roller 52 until the leading edge, i.e. downstream edge, of the sheet bundle sags downward at a sheet bundle path 58. In the paired bundle discharge rollers 60a and 60b, the roller 60a is the drive roller, and the roller 60b is a driven roller.

A sheet bundle stacking tray 80 for the folded sheet bundles can stack the sheet bundles that have been folded by the paired folding rollers 57a and 57b and discharged by the paired bundle discharge rollers 60a and 60b. The folded sheet holder 81 keeps the sheet bundle discharged inside the sheet bundle stacking tray 80 using a spring or its own weight.

The following describes the construction of the processing

tray 8, the saddle stitching unit 30, and the folding unit 50 of the sheet post-processing apparatus 2 in detail in reference to Fig. 3 and later drawings.

Fig. 3 is a plan view for the processing tray 8. A first pulley 10 and a second pulley 11 have a feed belt 12 stretched tightly therebetween, and are positioned at substantially the center of the sheet in the width direction. On a first pulley shaft 10a, lower feed rollers 18 are located in two locations on each side of the sheet and substantially at the center of the sheet in the width direction thereof. The lower feed rollers 18 are hollow and tire-shaped rollers.

On the first pulley shaft 10a, there are formed two first pulleys 10 for rotating the feed belt 12 as mentioned above. The first pulleys 10 are driven to rotate counterclockwise by the rotation of the first pulley shaft 10a in Fig. 2 using a one-way clutch 75 interposed between the first pulleys 10 and the first pulley shaft 10a. The drive is cut and stops when rotating to the clockwise direction. The first pulley shaft 10a is interconnected via a pulley 73 fixed to the first pulley shaft 10a, a timing belt 74, and gear pulleys 72 and 71 to a motor shaft 70a on a stepping motor 70 which serves as a source for the feed drive.

Therefore, the lower feed roller 18 fixed to the first pulley shaft 10a is driven to rotate when the stepping motor 70 rotates to move the sheet on the processing tray 8 toward the staple in Fig. 2 (in the direction of an arrow B in Figs. 2 and 3). The feed belt 12, however, is stopped because no drive force is transmitted thereto because of the one-way clutch 75. If the stepping motor 70 rotates to move toward a sheet elevator tray 90, the lower feed roller 18 and the feed belt 12 rotate toward the elevator tray 90 (in the direction of an arrow A in Figs. 2 and 3).

The following describes the feed belt 12 in reference to Fig. 12. The feed belt 12 stretched between the first pulley 10 having the one-way clutch 75 interposed at the first pulley shaft 10a and the second pulley 11, has a pushing pawl 13 formed thereon. A pushing pawl sensor 76 engaged with the pushing pawl 13 and a pushing pawl detecting arm 77 are formed at the bottom



of the processing tray 8 to detect the home position, i.e. position HP in Fig. 12, for the pushing pawl 13. The home position (HP) is determined at the position where the pushing pawl sensor 76 is turned from OFF to ON by the pushing pawl detecting arm 77 pressed by the pushing pawl 13 moved by the feed belt 12. The positional relationship is illustrated in Fig. 12. Let P denote a nip for the lower feed roller 18 and the upper feed roller 19, L1 a length from the nip P to a stopper 21, and L2 a length from the nip P to the pushing pawl 13 along the feed belt 12. L1 and L2 are set as  $L1 < L2$ .

The upper feed roller 19 is moved down by the action of a cam or the like (not shown) to press the lower feed roller 18.

Afterward, if the stepping motor 70 rotates the first pulley shaft 10a counterclockwise (in the direction of an arrow A in Figs. 2 and 3), then the lower feed roller 18 starts rotating to move the sheet bundle toward the elevator tray 90 (in the direction of the arrow A).

Note that also the upper feed roller 19 is rotated by the stepping motor 70 (see Fig. 3). Therefore, the sheet bundle is moved in the direction of the arrow A from the position of the stopper 21 inside the saddle stitching unit 30, by the rotation of the lower feed roller 18 and the upper feed roller 19. When the sheet bundle passes the nip position P, the pushing pawl 13 hits with rotation of the feed belt 12. With the pushing pawl 13, the sheet bundle is fed to the elevator tray 90 while being pressed in the direction of the arrow A. Because of  $L1 < L2$  as mentioned above, the pushing pawl 13 presses the bottom of the sheet bundle upward from the right side in Fig. 12, thereby always pressing the edge of the sheet bundle vertically. This does not cause excess stress in the transferring of the sheet bundle.

When binding, the pushing pawl 13 moves counterclockwise from the position HP in Fig. 12 before receiving the sheet bundle moved from the stopper 21 by the paired rollers 18 and 19 synchronized therewith to feed the sheet bundle and push it out.

However, if the sheets fed into the processing tray 8 are not saddle-stitched by the saddle stitching unit 30, the sheet bundle is not required to be moved to the stopper 21 position.

The stepping motor 70 is driven in advance to move the pushing

pawl 13 from the HP position in Fig. 12 to a movement idle position ( $L2 + \alpha$  or Pre HP position in Fig. 12) away from the nipping position of the lower feed roller 18 and the upper feed roller 19 in a direction toward the elevator tray 90. The increased distance ( $L2 + \alpha$ ) can be set by changing a step number count of the stepping motor 70. If the present sheet post-processing apparatus 2 does not need to saddle-stitch the sheets, the sheets do not need to be transferred to the stopper 21, but the pushing pawl 13 can be moved to the Pre HP position in advance to stack the sheets on the elevator tray 90 before pushing the sheet bundle out. This means that the sheet post-processing apparatus 2 can handle a high-speed copier.

Note that if the Pre HP position of the pushing pawl 13 is a position where the feed guide 7 and the top of the pushing pawl 13 overlap each other, as shown in Fig. 12, the sheets fed one by one can be securely stacked at the Pre HP position where the pushing pawl 13 exists. Such an arrangement allows the pushing pawl 13 to deliver the sheet bundle to the elevator tray 90 quickly.

The saddle stitching unit 30, as shown in Fig. 13, has right and left unit frames 40 and 41, guide rods 33 and 34, screw shafts 35 and 36, drive shafts 37 and 38 formed between the frames 40 and 41, the anvil unit 32 thereabove and the driving head unit 31 therebelow. The screw shaft 36 is engaged with the driving head unit 31. The driving head unit 31 is moved in the horizontal direction in Fig. 16 by rotation of the screw shaft 36. The anvil unit 32 also is arranged similarly. The screw shaft 36 is connected with a stapler slide motor 42 via a gear outside the unit frame 41. Drive force of the stapler slide motor 42 is transmitted also to the anvil unit 32 by a timing belt 43. This allows the driving head unit 31 and the anvil unit 32 to move in a direction (horizontal direction in Fig. 13) traversing the sheet feed direction without deviation to vertical positions thereof.

The stapler slide motor 42, therefore, can be driven to control the driving head unit 31 and the anvil unit 32 to move to desired positions depending on the width of the sheet, thereby allowing the staple to be driven at a desired position.

Top guides 46a, 46b, 46c and 46d, which are float preventing guide members, are movably supported on the guide rod 33 and the anvil drive shaft 37 above the feed path 25 in an area surrounded by the anvil unit 32 and the right and left unit frames 40 and 41. Compression springs 47a, 47b, 47c, 47d, 47e and 47f made of an elastic material are interposed between the unit frame 41 and the upper guide 46a, between the upper guide 46a and the upper guide 46b, between the upper guide 46b and the anvil unit 32, between the anvil unit 32 and the upper guide 46c, between the upper guide 46c and the upper guide 46d, and between the upper guide 46d and the unit frame 41. The top guides 46a, 46b, 46c and 46d move on the upper guide rod 33 and the anvil drive shaft 37 in coordination with the movement of the anvil unit 32.

As an example, when the sheet stack is saddle-stitched on a right side in Fig. 14, as shown in Fig. 15, the driving head unit 31 and the anvil unit 32 move to the desired stitching positions on the right side while maintaining the relative positional relationship therebetween. Along with the movement, the compression springs 47d, 47e and 47f on the right side are compressed by the anvil unit 32 in coordination with the movement of the anvil unit 32. The top guides 46c and 46d are moved to the right side, pushed by the compression springs 47d and 47e.

The compression springs 47a, 47b and 47c located to the left side of the anvil unit 32 are extended in coordination with the movement of the anvil unit 32. The top guides 46a and 46b also move to the right side to guide at the desired position depending on the sheet stitching position.

The drive forces for moving the head to drive the staples in the driving head unit 31, to move the staples, and to bend the staples in the anvil unit 32 are provided through a coupling device 44 from the sheet post-processing apparatus 2, and are also transmitted to the anvil unit 32 through a timing belt 45 on the unit frame 40. A moving arm 23 (Fig. 16) and the stopper are connected therewith by a connecting pin 23c, a connecting lever 22, and a connecting pin 21a. The stopper 21 is pivoted by the first pulley shaft 10a.

The following describes the appearance and disappearance of the stopper 21 in the staple path to set the staple driving

positions on the edge of the sheet stack with the driving head unit 31 moved in the width direction of the sheets, in reference to Figs. 13 and 16. Below the driving head unit 31 in Fig. 13, there is formed the stopper engaging projection 24 that can engage the stopper 21 with the moving arm 23. With the moving of the driving head unit 31, the stopper engaging projection 24 is engaged with a moving arm projection 23b. This causes the moving arm 23 to rotate counterclockwise on the turning shaft 23a to move to the position of the chained, double-dashed line in Fig. 16. The stopper 21, therefore, can not prevent the driving head unit 31 and the anvil unit 32 from moving in the width direction of the sheet bundle.

In the above-mentioned operational construction, the movement of the driving head unit 31 engages the stopper engaging projection 24 with the moving arm projection 23b, as shown in Fig. 5, but a plurality of stoppers 221 may be alternatively formed in position and all can be retracted from the staple path and the sheet bundle feed path 25.

Fig. 8 is the block diagram depicting for control operation of the sheet post-processing apparatus 2. The control block 149 comprises a central processing unit (CPU), a ROM for storing control means in advance that the CPU executes, and RAM for storing the operational data of the CPU and control data received from the main body 1 of the copier 20.

The control block 149 has I/O devices formed therein. Arrows directing toward the control block 149 indicate input, and arrows away from the control block 149 indicate output.

A circuit for aligning the sheets has a front aligning HP sensor 151 and a rear aligning HP sensor 152 for setting a home position (HP) of the aligning plates 9 that can align both ends of the sheets in the processing tray 8. The aligning plates 9 (Fig. 3) are idle at the positions of the front aligning HP sensor 151 and the rear aligning HP sensor 152 until the first sheet is fed into the processing tray 8. A front aligning motor 14 is a pulse motor for moving the front aligning plate 9, and a rear aligning motor 14 is a pulse motor for moving the rear aligning plate 9. The aligning motors 14 move the respective aligning plates 9 to align the width of the sheet bundle according

to the width thereof. The aligning plates 9 can freely move for a specified volume of the sheet bundles in the direction traversing the feed direction.

5 In turn, a circuit for the elevator tray 90 comprises a paper sensor 93 for detecting a top surface of the sheets thereon, an elevation clock sensor 150 for detecting the number of rotations of an elevator tray motor 155 with an encoder, and an upper limit switch 153 and a lower limit switch 154 to limit an elevation range for the elevator tray 90. The circuit for the elevator  
10 tray 90 controls the elevator tray motor 155 with signals input from the sensors 93 and 159 and the switches 153 and 154 to drive the elevator tray 90.

A circuit for detecting whether or not a sheet or sheet bundle is stacked on the elevator tray 90 in the sheet bundle stacking  
15 tray 80, is equipped with an elevator tray paper sensor 156 for detecting the presence on the elevator tray 90 and a folded sheet bundle paper sensor 157 that is a detecting sensor in the sheet bundle stacking tray 80. These sensors 156 and 157 also are used as sensors for issuing alarms to an operator if any sheet remains  
20 before the sheet post-processing apparatus 2 is started or if a sheet bundle is not removed after a predetermined time elapses.

A circuit for a door open-close detection for detecting the opening of a door of the sheet post-processing apparatus 2 and  
25 whether or not the main body 1 of the image forming apparatus 20 has the sheet post-processing apparatus 2 mounted has a front door sensor 158, and a joint switch 150 for detecting whether or not the main body 1 of the image forming apparatus 20 has the sheet post-processing apparatus 2 mounted correctly.

30 The circuit for the sheet feed operation and the sheet bundle feed operation with sheets stacked comprises a sheet detecting sensor 4 for detecting on the feed guide 3 that a sheet is fed from the main body 1 of the copier 20 to the sheet post-processing apparatus 2, a processing tray sheet detecting sensor 160 for  
35 detecting the presence of a sheet on the processing tray 8, a center stitching position sensor 95 and a center stitching and folding position sensor 95' for detecting a leading end of the sheet bundle in the feed direction to detect the same position

for folding the sheets as the staple driven position, a pushing pawl sensor 76 for detecting a home position of the pushing pawl 13 formed on the feed belt 12 for transferring the sheet bundle on the processing tray 8 toward the elevator tray 90, and an upper stack feed roller HP sensor 161 for detecting the home position at which the upper stack feed roller 51 at an inlet of the folding unit 50 is separated from the lower feed roller 52. The circuit can control the feed motor 162 and the stepping motor 70 according to signals from the respective sensors. The rotating force of the feed motor 162 is transmitted to the paired feed rollers 5, the paired discharge rollers 6, the upper stack feed roller 51, the lower feed roller 52, and the paired stack discharge rollers 60a and 60b.

The reverse rotation of the feed motor 162 turns the upper roller moving cam 68 to move the paired stack feed rollers 51.

The rotating force of the stepping motor 70 is transmitted to the lower feed roller 18 and the upper feed roller 19 formed on the processing tray 8 and the first pulley 10 to circulate the feed belt 12.

The circuit for controlling the paddle 17 comprises a paddle HP sensor 163 to detect the rotating position of the paddle 17 and an upper feed HP sensor 164 to detect the position where the upper feed roller 19 is separated from the lower feed roller 18, thereby controlling a paddle motor 165 according to signals from the sensors 163 and 164.

The circuit for controlling the staple/folding operation is comprised of a staple HP sensor 166 to detect that the driving head unit 31 and the anvil unit 32 in the saddle stitching unit 30 can drive staples, a staple sensor 167 to detect whether or not the driving head unit 31 has staples set therein, a staple slide HP sensor 168 to detect whether or not the sheet bundle is at a home position (Fig. 13) when it is started to move in the sheet feed direction between the driving head unit 31 and the anvil unit 32, a staple/folding clock sensor 171 to detect the rotation direction of a staple/folding motor 170 that can switch the drives of the saddle stitching unit 30 and the folding unit 50 to normal or reverse, and a safety switch 172 for detecting that the saddle stitching unit 30 and the folding unit 59 are

operable. The circuit having the sensors and switches mentioned above controls the stapler slide motor 42 and the staple/folding motor 170.

The stapler slide motor 42 transmits the rotating force to the screw shaft 36 to move the driving head unit 31 and the anvil unit 32 in the direction traversing the sheet feed direction.

The staple/folding motor 170 is arranged to drive the coupling device 44 (Fig. 14) for the saddle stitching unit 30 in one of the normal and reverse rotation directions or the coupling device 137 (Fig. 6) for the folding unit 50 in the other rotation direction.

Next, the following describes the operations in the process modes of the sheet post-processing apparatus 2.

Three basic processing modes include:

(1) Non-staple mode: a mode for stacking sheets onto the elevator tray 90 without stitching;

(2) Side staple mode: a mode for saddle-stitching the sheets at one or a plurality of positions on an end (side) thereof in the sheet feed direction before stacking the sheets onto the elevator tray 90.

(3) Saddle step mode: a mode for stitching the sheets at a plurality of positions on a half length of sheet in the sheet feed direction and for folding and binding the sheets at the stitched positions before stacking the sheets onto the sheet bundle stacking tray 80.

(1) Non-staple mode

With this mode selected, the control block 149 drives the stepping motor 70 to circulate the feed belt 12 to move the pushing pawl 13 at the home position (HP in Fig. 12) to the pre-home position (Pre HP in Fig. 12) that is a sheet stacking reference position on the processing tray 8 before stopping.

At the same time, the control block 149 drives the feed motor 162 to rotate the paired feed rollers 5 and the paired discharge rollers 6, and waits for a sheet to be discharged from the discharge rollers 1a and 1b of the main body 1 of the copier 20.

When the sheet is discharged, the paired feed rollers 5 and the paired discharge rollers 6 feed the sheet to the processing tray 8. The sheet detecting sensor 4 detects the sheet, and measures

start timings of the aligning motors 14 for the aligning plates 9 and the paddle motor 165 for rotating the paddle 17.

The control block 149 drives the aligning motors 14 and the paddle motor 165 while the sheet is discharged and stacked onto the processing tray 8. With the drive, the aligning plates 9 move in the width direction traversing the sheet feed direction to align both ends of the sheet, and the paddle 17 is rotated to make one end of the sheet strike the pushing pawl 13 at the Pre HP position to align the sheets. This operation is repeated every time the sheet is discharged to the processing tray 8. If a predetermined number of sheets is aligned to the pushing pawl 13, the control block 149 stops the feed motor 162 and the paddle motor 165 from rotating, and also restarts the stepping motor 70 for driving the feed belt 12. With this operation, the sheet bundle is moved to the elevator tray 90 (direction of the arrow A in Fig. 3). The moved sheet bundle is stacked on the elevator tray 90.

Along with the discharge of the sheet bundle, the control block 149 makes the elevator tray motor 155 move down to a certain distance in a downward direction of the elevator tray 90 once. Subsequently, it drives the elevator tray motor 155 upward until the paper sensor 93 detects the top sheet before stopping, and makes the elevator tray motor 155 idle until the following sheet bundle is placed thereupon.

## (2) Side staple mode

When the side staple mode is selected, the control block 149 drives the feed motor 162 to rotate the paired feed rollers 5 and the paired discharge rollers 6 to deliver a sheet from the main body 1 of the copier 20 to the processing tray 8 to stack.

The control block 149 also drives the aligning motors 14 and the paddle motor 165 while the sheet is discharged and stacked.

With that operation, the sheet is aligned on both ends in the width direction thereof by the aligning plates 9, and the leading end of the sheet is transferred to the stopper 21 to stop. This operation is repeated for a specified number of sheets.

In the state where the sheet bundle is restricted by the stopper 21, the upper feed roller 19 is moved to the lower feed roller 18 to make the upper feed roller 19 and the lower feed



roller 18 nip the sheet bundle.

At that time, the driving head unit 31 and the anvil unit 32 are both positioned at the staple home position shown in Fig. 13.

5       The staple home position is a position where one-position stitching is made on the left unit frame 41 shown in Fig. 13, that is, on the back side of the copier 20 and the sheet post-processing apparatus 2 shown in Fig. 1. In more detail, the position is determined by a specific number of pulses from  
10       the HP sensor (not shown) located on the left unit frame 41 side shown in Fig. 13.

When the one-position stitching is specified, the control block 149 makes the staple/folding motor 170 to rotate in the staple moving direction to make the driving head unit 31 and the  
15       anvil unit 32 proceed with stitching. It should be noted that to stitch the sheets at a plurality of positions on the ends thereof, the stapler slide motor 42 must be driven to move the driving head unit 31 and the anvil unit 32 from the staple home position to a desired staple position before proceeding with  
20       stitching.

After the stitching process is finished, the stitched sheet bundle is moved to the elevator tray 90 side (direction of the arrow A in Fig. 3) with the lower feed roller 18, upper feed roller 19, and the feed belt 12 driven by the stepping motor 70. This  
25       delivers the sheet bundle to the lower feed roller 18, the upper feed roller 19, and pushing pawl 13 in this order to stack it onto the elevator tray 90. The operation of the elevator tray 90 is the same as in the non-staple mode described above, so that the explanation is omitted.

### 30       (3) Saddle staple mode

This mode stitches and folds around the center position of the sheet length in the sheet feed direction. Because the stacking of the sheets discharged from the main body 1 onto the processing tray 8 is similar to that of the side staple mode of operation  
35       described above, the description is omitted.

After the sheets are aligned and stacked on the processing tray 8, the upper feed roller 19 is moved down to the lower feed roller 18 side to make the upper feed roller 19 and the lower

feed roller 18 nip the sheet bundle. In turn, the stopper 21 is retracted from the feed path 25 before the control block 149 drives the stapler slide motor 42 to transfer the sheet bundle in the arrow B direction in Fig. 3. The drive allows the stopper engaging projection 24 on the driving head unit 31 also to move as shown in Figs. 16 to engage the moving arm 23 to retract the stopper 21 from an area where the driving head unit 31 and the anvil unit 32 are located.

It should be noted that the stopper 21 may be alternatively repositioned by a single wide stopper 421 (Fig. 4) or a plurality of stoppers 221 (Fig. 5) extending in the direction in which the driving head unit 31 moves along the guide rod 34, the direction being a direction traversing or orthogonal to the direction in which the sheets are discharged from the copier 20 to the sheet post-processing apparatus 2 or a direction traversing or orthogonal to the direction in which the sheet bundle is fed in the sheet bundle feed path. By the engagement of the stopper engaging projection 24 of the driving head unit 31 with the moving arm 23, all the stoppers are retracted from the moving area of the driving head unit 31 and the anvil unit 32 to open the sheet bundle feed path.

The stopper engaging projection 24 is formed in the driving head unit 31 in the embodiment described above. Alternatively, the stopper engaging projection 24 can be formed at the anvil unit 32 so as to retract the stopper from the moving area of the driving head unit 31 and the anvil unit 32 to open the sheet stack feed path.

In such a structure, the driving head unit 31 and the anvil unit 32 move from the home staple position shown in Fig. 16 along the guide rod 34 to open the sheet bundle feed path before stopping at the driving set positions in the direction traversing the sheet moving direction.

The stopping positions of the driving head unit 31 and the anvil unit 32, however, can be specifically controlled to change depending on the difference of an alignment reference with the aligning plate 9, and the difference of the sheet size, as will be described later.

The control block 149 rotates the stepping motor 70 in a

direction reverse to the non-staple and side staple modes. This drive makes the sheet bundle feed in the direction reverse (direction of the arrow B in Figs. 2 and 3) to the elevator tray 90. When in the feeding, the stack detecting sensor 54 in the folding unit 50 detects the leading edge of the sheet bundle in the feed direction, the upper feed roller 19 and the lower feed roller 18 feed the sheet bundle and stop it at a position where the approximate middle position in the sheet feed direction coincides with the stitching position according to the sheet length information in the feed direction sent in advance.

It should be noted that if the stepping motor 70 rotates in the reverse direction, the one-way clutch 75 interposed between the first pulley 10 and the first pulley shaft 10a for connecting the feed belt 12 prevents the rotating force of the stepping motor 70 from transmitting but maintains the feed belt 12 and the pushing pawl 13 stopped at the home position.

Next, the control block 149 rotates the staple/folding motor 170 to drive the drive shaft 38 and the anvil drive shaft 37 to rotate in the directions for operation to stitch. When there is a plurality of stitchings at a plurality of positions, the stapler slide motor 42 is driven to rotate the screw shafts 35 and 36 to move to specific positions in a direction traversing the sheet feed direction before stitching.

After saddle-stitching the sheet bundle at the plurality of positions, the driving head unit 31 and the anvil unit 32 are moved from the final stitching position to the home staple position shown in Fig. 13 along the guide rod 34. This disengages the stopper engaging projection 24 of the driving head unit 31 from the moving arm 23, makes the stoppers 21 (421 or 221) return to the moving area of the driving head unit 31 and the anvil unit 32, closes the feed path 25, and prepares for alignment of the leading edge of subsequent sheets.

Accordingly, in a stroke of the driving head unit 31 and the anvil unit 32 moving from the staple home position to the staple position and returning to the staple home position again, the position for saving the stopper 21 (421 or 221), the position for stitching process, the position for the stopper to return in the feed path 25, and the position for a guide 370 (which will

be described later) to guide the sheet bundle are already set.

It should be noted that timing when the stopper 21 (421 or 221) is returned from the position where the driving head unit 31 and the anvil unit 32 perform the saddle stitching for the final sheet stack into the feed path 25 is not required to wait until the sheet stack having saddle-stitching finished is entirely delivered from the sheet post-processing apparatus 2.

When the trailing end of the sheet stack S in the feed direction has passed the stopper 21 as shown in Fig. 17, for example, the stopper 21 (421 or 221) can be moved to the position to return into the feed path 25.

Therefore, alternatively, the driving head unit 31 and the anvil unit 32 can start to move at an instance when the driving head unit 31 and the anvil unit 32 reach a position to return the stopper 21 after the trailing end of the sheet bundle has passed the stopper 21, the instance being decided with respect to a size of the sheet, a sheet bundle feed speed, and other factors.

Such a scheme quickens the preparations for accepting a next sheet bundle.

In the embodiment, also, the driving head unit 31 formed upstream of the fixed feed guide 39, as shown in Figs. 18 and 19, has covers 380 fixedly disposed on both ends thereof. The cover 380 has a pre-guide 370 on a top thereof. The pre-guide 370 has a slope 370a to deviate the leading end of the sheet stack away from the upstream end of the fixed feed guide 39. Those means prevent the leading end of the sheet stack from being caught by the upstream end of the fixed feed guide 39 so as not to destroy the posture of the sheet stack and to prevent the sheets from buckling thereby ensuring the correct saddle stitching.

The pre-guide 370 is positioned more inwardly of the feed path 25 with respect to the fixed feed guide 39 as shown in Fig. 18 to prevent the leading edge of the sheet stack from getting caught by the upstream edge of the fixed feed guide 39. Furthermore, the downstream edge of the pre-guide 370 and the upstream end of the fixed feed guide 39 are overlapped each other in the feed direction of the sheet stack, as shown in Figs. 18 and 19, to prevent the leading edge of the sheet stack from entering thereinto.

When the sheet bundle aligned by the aligning plates 9 with reference to a center in the width direction is fed to the fixed feed guide 39, the pre-guide 370 moves to the center position in the width direction which is common to the sheets or to a position close thereto, for example, to the stitching position together with the driving head unit 31. Such control guides the sheet bundle into the feed guide with good balance.

When the sheet bundle aligned with reference to either right or left edge of a sheet in a width direction thereof by the aligning plate 9 is fed into the fixed feed guide 39, a center position of the sheet differs for the size of the sheet.

Therefore, the pre-guide 370 moves to the center position in the width direction according to the size of the sheet or to the position close thereto together with the driving head unit 31. Such control guides the sheet bundle into the feed guide with good balance.

In the embodiment, the pre-guide 370 is fixed to the driving head unit 31 and is movable together with the driving head unit 31. Alternatively, the pre-guide 370 itself may move independently.

In the embodiment, the pre-guide 370 is formed on the drive head unit 31 as seen from the sheet stack since a leading edge of the sheet stack curled on the side of the drive head unit 31 disposed on a printing side of the sheets tends to get caught by the upstream edge of the feed guide 39 because curling usually occurs on the leading edge of the sheet. Alternatively, as the feed guide may be attached to the anvil unit 32, the pre-guide 370 may be placed on the side of the anvil unit 32 as seen from the sheet stack.

The fixed feed guide 39 has a cutout portion 390 on the upstream edge thereof as shown in Figs. 18 and 19. The cutout portion 390 is effective in guiding the ends of the sheet bundle smoothly along a guide surface of the fixed feed guide 39 according to feeding of the sheet bundle.

When the sheet bundle has been fed to the stitching position, on the other hand, the leading edge of the sheet bundle in the feed direction is already located at a position having passed over an area between the lower bundle feed roller 52 in the folding

unit 50 and the upper stack feed roller 51 separated from the lower bundle feed roller 52.

After the stitching is completed, the sheet bundle is fed to come to about center in the feed direction, that is, to bring the stitched position become the folding position. The staple/folding motor 170 is then driven in a reverse direction of the stitching process. The pair of folding rollers 57a and 57b is rotated in the directions of nipping the sheet bundle S, and the abutting plate 55 is moved down as shown in Fig. 20. At the same time, the backup guides 59a and 59b are moved to release the surfaces of the folding rollers on the sheet bundle side.

After the abutting plate 55 is moved to allow the rotating folding rollers 57a and 57b to nip the sheet bundle therebetween, the sheet bundle S is rolled in between the paired folding rollers 57a and 57b. After that, while the abutting plate 55 moves in the direction separating from the sheet bundle, the sheet bundle is further folded in by the paired folding rollers 57a and 57b.

At the stage, the feed motor 162 rotates the upper stack feed roller 51, the lower bundle feed roller 52, and the paired stack discharge rollers 60a and 60b in the directions of delivering the sheet bundle into the sheet bundle stacking tray 80. The paired folding rollers 57a and 57b, on the other hand, are stopped when the abutting plate 55 moves up and is detected by an abutting plate HP sensor (not shown).

The sheet bundle S nipped and fed by the paired stack discharge rollers 60a and 60b is discharged to and stacked on the sheet bundle stacking tray 80. The folded sheet bundle is held down by the folded sheet holder 81 so that it does not open, thereby not preventing a subsequent folded sheet bundle from being fed in.

It should be noted that the upper stack feed roller 51 separates from the lower bundle feed roller 52, moves up, and prepares to feed in the next sheet bundle when a period of time available for the paired stack discharge rollers 60a and 60b to deliver the sheet bundle has elapsed.

In the saddle stitch mode in the embodiment as described above, the stitching process and the folding process are made consecutively. It should be known that only the folding process

can be performed without the stitching process. Furthermore, the folded sheet bundle device can stack thereon only the sheet bundles folded but not stitched.

5 In the present invention described in detail so far, at least one of the head unit and the anvil unit is formed of the base unit engaged with the head unit support member or the anvil unit support member, and the attachment block detachable freely from the base unit. In maintenance, the attachment block can be detached from the base unit so that maintenance can be made easily,  
10 and saddle stitching can be made securely. In addition, the stitching operation is inhibited when the base unit has not connect the attachment block properly. This prevents jamming in stitching operation and keeps the units from being damaged by improper attachment.

15 While the invention has been explained with reference to the specific embodiments of the invention, the explanation is illustrative and the invention is limited only by the appended claims.